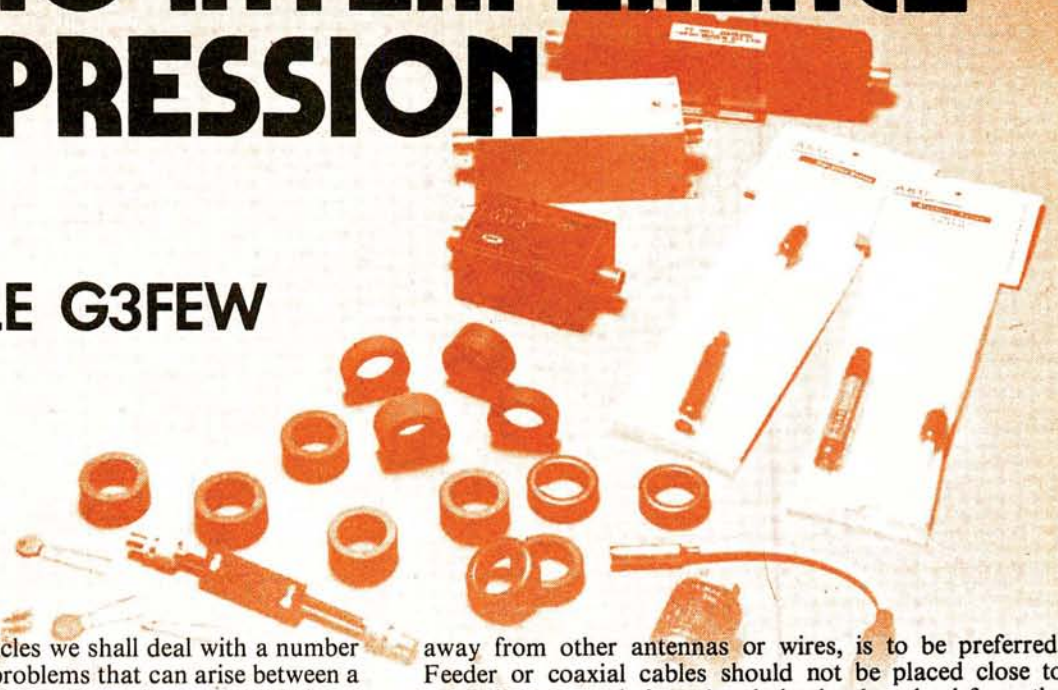
RADIO INTERFERENCE SUPPRESSION

PART 1

E.A.RULE G3FEW



In this short series of articles we shall deal with a number of the radio interference problems that can arise between a transmitter and nearby electronic equipment. There is no one magic cure, and each case can only be examined for its own individual cure which can sometimes only be found after many hours of frustrating investigation. Complaints of radio frequency interference (r.f.i.) should be dealt with in a polite manner and the ideal method is to have a third party to act as a go-between. The self-interest of each of the affected parties can thereby be avoided and each particular case examined on the facts alone. Don't start off by telling your neighbour that it is his equipment that's at fault (even if you know it is) before you have made an investigation. He may well retort that his equipment is perfect until you start transmitting!

Once a complaint is received it is suggested that you close down until you can start the investigations. This will show concern about the problem. At all times show a willingness to help and, most important, be polite. Your neighbour may have spent far more money on equipment than you have on yours, and will be equally entitled to expect it to be faultless. Don't do anything that could sour the relationship between yourself and your neighbour, you need his co-operation if the outcome is to enable you to transmit whenever you want to, regardless of peak viewing times, etc.

First, ensure that any electronic equipment that you own can be operated while you are transmitting and that it is free from r.f.i. A demonstration that you can transmit without problems to your own equipment is very disarming as it implies (without saying so) that the fault must be with the neighbour's equipment and not yours! Make sure that your transmitter is correctly installed according to the manufacturer's instructions, and also that the antenna system is correctly matched. Read the operating instructions carefully; the writer is still surprised by the number of people who do not read the instructions supplied with equipment, sometimes not even doing so when they have some problems. Never assume that you know it all, you might just be wrong for once.

Antennas used for transmitting should not be placed near other equipment, and an outside location in the clear, away from other antennas or wires, is to be preferred. Feeder or coaxial cables should not be placed close to other feeders, and sharp bends in the downlead from the antenna to the transmitter should be avoided. A low-pass filter (one which passes signals below a certain frequency but blocks those above that frequency) should always be used between the transmitter and its antenna system even though the transmitter may already contain harmonic filters. The complete design of a high-quality, low-pass filter will be given later, along with designs and details of other types. A low-pass filter should be installed into the antenna system as shown in Fig. 1. Note the position of the s.w.r. meter. Such meters contain semiconductor diodes to provide the current for the meter, and these diodes can generate considerable levels of harmonics. For this reason, after the standing wave ratio has been checked with the meter in Position 1, it should be moved to Position 2. It will still serve as an output indicator but cannot measure actual s.w.r. in this position, however the harmonics generated by its diodes are suppressed.

Low-pass filters are designed to be used with an antenna system of a particular impedance (usually 50 ohms), and will not work correctly if any odd length of wire is used instead of a matched antenna. Good quality coaxial cable should be used and more important, coaxial cable from the **same batch** should be used throughout the antenna system. The impedance of coaxial cable is a nominal one and can vary from batch to batch. Joining up odd lengths of the cable may cause standing waves and therefore radiation of power from the feeder, which in turn will greatly increase the risk of r.f.i. A well-installed antenna system is well worth the extra expense and could

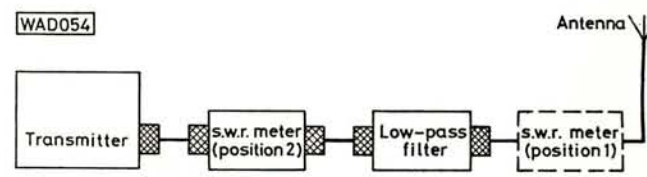


Fig. 1: General layout of equipment for transmitting

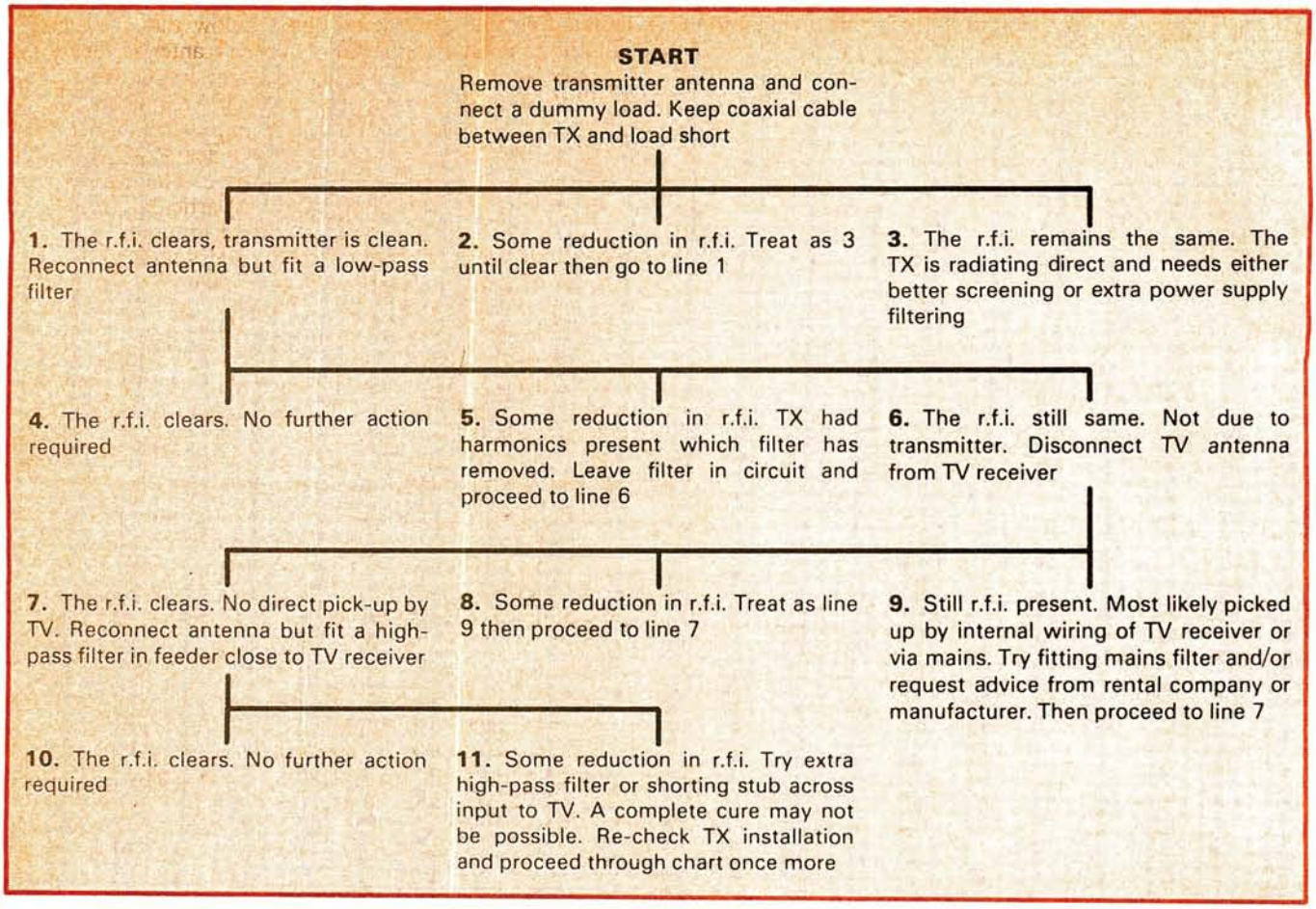

START
Remove transmitter antenna and connect a dummy load. Keep coaxial cable between TX and load short
1. The r.f.i. clears, transmitter is clean. Reconnect antenna but fit a low-pass filter
2. Some reduction in r.f.i. Treat as 3 until clear then go to line 1
3. The r.f.i. remains the same. The TX is radiating direct and needs either better screening or extra power supply filtering
4. The r.f.i. clears. No further action required
5. Some reduction in r.f.i. TX had harmonics present which filter has removed. Leave filter in circuit and proceed to line 6
6. The r.f.i. still same. Not due to transmitter. Disconnect TV antenna from TV receiver
7. The r.f.i. clears. No direct pick-up by TV. Reconnect antenna but fit a high-pass filter in feeder close to TV receiver
8. Some reduction in r.f.i. Treat as line 9 then proceed to line 7
9. Still r.f.i. present. Most likely picked up by internal wiring of TV receiver or via mains. Try fitting mains filter and/or request advice from rental company or manufacturer. Then proceed to line 7
10. The r.f.i. clears. No further action required
11. Some reduction in r.f.i. Try extra high-pass filter or shorting stub across input to TV. A complete cure may not be possible. Re-check TX installation and proceed through chart once more

Fig. 2: Interference Tracing Chart. This chart is intended as a general guide in tracing the cause of r.f.i. In many cases more than one cause could be present and it is possible that a number of different filters may be needed before the r.f.i. is removed. Proceed in an orderly manner down the chart and the causes of the r.f.i. should become known. The use of a third party to make the checks will be found most helpful, he can check results while you operate the transmitter, and also act as a go-between. Any filters fitted to your neighbour's equipment should be neat and "professional"; a bundle of odd components left "hanging" on the back of the receiver will not instil confidence in your abilities

save the cost of expensive filters later. As the radiated signal falls according to the square of the distance, keeping the initial distance between the transmitting antenna and other systems as great as possible is important. Each doubling of this distance will reduce the signal strength by a factor of four times and greatly reduce the chances of r.f.i.

Most commercial transmitters are built to a very high standard as far as the spurious and/or harmonic content of their output is concerned. But the level of these spurious signals will be relative to other factors. For example, if we have a 10 watt transmitter having a harmonic content say 40dB down (10 000 times) there will be 1 milliwatt of power contained in its harmonics. This is more than enough to cause severe interference to (say) a nearby TV receiver if one of the harmonics happens to fall on the same frequency as the wanted signal. Even much lower levels of harmonics can cause problems in areas of fringe reception, bearing in mind that the transmitter and its antenna will be closer to the receiver than the TV transmitting station. A typical transmitter would have its harmonics suppressed by around 60dB and this can be improved to around 120 to 140dB by adding a low-pass filter. These figures refer to harmonics in the UK TV u.h.f. band. Regretfully, even with this amount of suppression it is still possible to have enough harmonic power present to cause r.f.i., especially if a high-power transmitter or linear amplifier is in use. By way of interest, 10 watts across 50 ohms equals 22·36 volts. 120dB equals a voltage ratio of 1 000 000. So the harmonic level is

$$\frac{22{\cdot}36}{1\,000\,000} = 0{\cdot}000022 \text{ volts}$$

or 22 microvolts, more than enough to cause interference! It's all a matter of relative signal strengths.

Referring back to Fig. 1, the low-pass filter should be placed as close to the transmitter as possible and its metal case should not be allowed to touch the transmitter chassis. The only electrical connections should be via its input and output sockets, with the coaxial connection between the transmitter and filter as short as possible. All interconnections must be properly terminated with 50 ohm plugs/sockets for optimum results. A good filter costs money and you only get what you pay for. Many of the low-pass filters at present offered on the CB market are quite useless and care is needed when deciding which type to purchase. The price and external appearance are no clue to how good a filter is. Pick one from a reputable manufacturer or one that has been recommended in a review. Even a good filter will not ensure 100 per cent success for the reasons outlined above regarding signal strengths. But even if the low-pass filter doesn't cure the problem, leave it in circuit while trying other approaches as the r.f.i. may be coming from two or more sources.

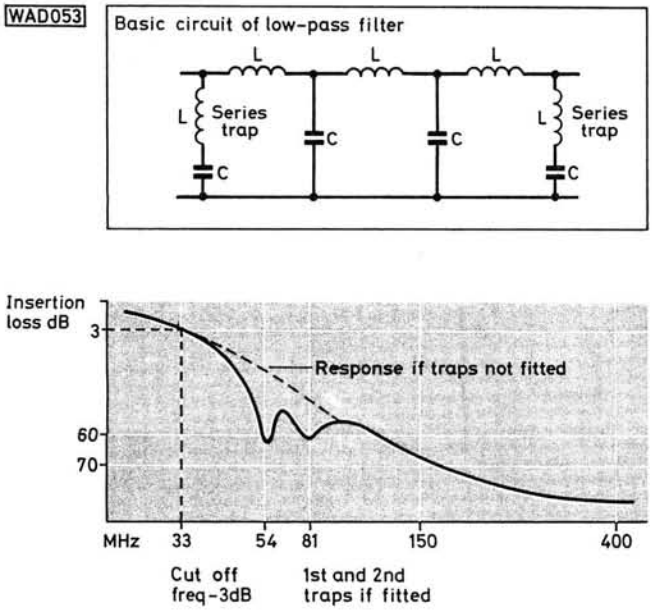


Fig. 3(a): Typical frequency response of low-pass filter (not to scale). The series tuned traps (if fitted) will normally be tuned to the second and/or third harmonics of the 27 to 30MHz band. The basic circuit is as shown

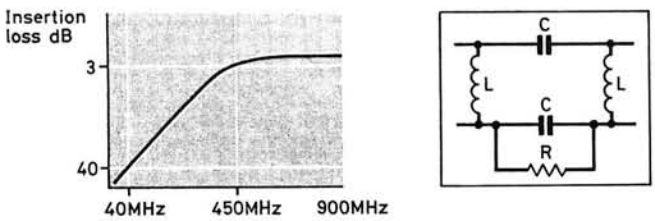


Fig. 3(b): Typical circuit and frequency response of a high-pass filter suitable for use with the UK u.h.f. TV service

Proceed by adding filters, etc., until the r.f.i. is removed. Once this has been done you can remove filters one by one to see which ones are needed. Just trying one filter at a time and, if it doesn't work, trying another will not get you anywhere if the cause is due to more than one source. You **must** proceed in an orderly manner as outlined later if success is to be achieved.

An interference tracing chart is shown in Fig. 2. Start at the top and proceed down the columns as indicated in an orderly manner, taking one step at a time. In general, if the problem is due to harmonics of the transmitted signal, this will be recognised by the fact that a small shift in transmitter frequency will cause a change in the effect the harmonic is having on the receiver, or the interference may only show up on certain channels either on receive or transmit. On the other hand, if the problem is due to "blanking" of the receiver due to the amount of r.f. present, changing frequency by a small amount will not have much effect. In other words, r.f.i. from harmonics tends to occur at particular points in the frequency spectrum whereas blanking due to strong r.f. fields tends to be general over a broad band. These comments of course only apply when dealing with receivers of one type or another. Hi-Fi and other electronic equipment normally only suffers from the blanking effect of strong r.f. fields at the transmitter fundamental frequency. This type of r.f.i. will be dealt with in detail later in the series.

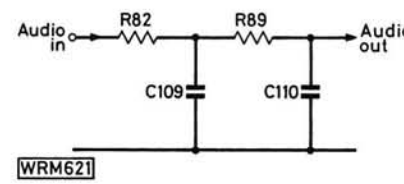
Mention is made in the chart of high-pass filters. These are filters which will pass all frequencies above a certain design frequency but reject those below that frequency. This type of filter is used in a receiver antenna feeder to prevent (say) h.f. band signals getting into a u.h.f. TV receiver. Typical frequency response curves of both low-pass and high-pass types are shown in Fig. 3. These two types of filter are the most common ones used and combinations of these can be very effective. There are other types which are "tuned" to reject one particular frequency and although these can be very useful in certain difficult cases, they tend to be tricky in setting up. However, details of some of these other types will be given later. One special type is called a "braid-breaker"; this is used mainly in TV antenna leads to prevent signals passing down the outside braiding of the coaxial cable into the receiver. For example, the average TV antenna feeder is of a suitable length to act as a quarter-wave vertical antenna at 27/30MHz, and this results in signals from the CB band or 28MHz amateur band being injected at considerable strength directly into the front end of the receiver. By using a braid-breaker filter this vertical antenna is "disconnected" from the receiver, but the wanted higher frequencies are allowed to pass. This type of filter is also very effective in reducing TV timebase radiation via the TV antenna into nearby communications receivers, so can be a double blessing in practice. It not only prevents your signal getting into your neighbour's TV but also prevents his timebase signals getting into your receiver as well (worth fitting for that alone even if your neighbour is not getting r.f.i.!).

Next month in Part 2, we shall be giving full constructional details of both low-pass and high-pass filters suitable for use with h.f. band transmitters and u.h.f. TV receivers. Details will also be given of braid-breaker filters and quarter-wave shorting stubs, etc.

Mods — 17

▶▶▶*continued from page 37*

tally is a small green ceramic capacitor. It's as well to make sure that you have the right one as Harry now suggests that you crunch it with the pliers. I gather that not only is the sound of the capacitor breaking very satisfying, but when it has gone, the audio from the set is greatly improved. Harry calls it an added brightness. One reason that I have been given for the effectiveness of this unlikely mod is that the set was originally designed to suit Japanese voices, which tend to be slightly higher than European ones, and that's why the audio tailoring circuit needs to be modified. I don't know whether this is true or not but everyone who has carried out this mod has said how much their audio has improved.



Hopefully next month will be FT 290 month but until then, please continue to send in your mods and your requests. The address is, as always, R.S. Hall, Room 301 Hatfield House, Stamford Street, London SE1 9LS.

73
Sam.

RADIO INTERFERENCE SUPPRESSION PART 2

E.A.RULE G3FEW

This month we shall be giving full constructional details of low-pass, high-pass and notch filters which, if carefully constructed as shown, will provide very efficient suppression of unwanted frequencies.

Low-pass Filter

The low-pass filter (Fig. 4) has a cut-off frequency of around 33MHz and an ultimate rejection of over 80dB at u.h.f. TV frequencies. It is also fitted with two traps, L1/C1 and L7/C6, tuned to the second harmonic of the 27–30MHz band. The filter is designed to handle powers considerably greater than the 400 watt p.e.p. limit of the UK Amateur bands. Its impedance is 50 ohms, and when used with a correctly matched antenna system the v.s.w.r. is less than 1·2 to 1. The filter is symmetrical and may be connected in circuit either way round. Constructional details are given in Figs. 5–8. In all cases, measurements are critical if optimum performance is to be obtained.

Components

This unit really takes us back to the old days of home-construction—apart from the coaxial connectors **all** the components are home-made.

The coils L1, 2, 4, 6 and 7 are all made from 18 s.w.g. enamelled copper wire, close-wound on a 12·7mm mandrel (such as a $\frac{1}{2}$in twist-drill shank), and then carefully stretched to the lengths given in Fig. 6. The spacing of the turns in each finished coil should be equal.

The capacitors (Fig. 7) are made from small pieces of 0·6mm thickness double-sided, glass-fibre p.c.b. material, the copper cladding on the opposite faces forming the two plates. It is essential to use the specified type and thickness of material, otherwise the capacitance values (and therefore the operating frequencies) will be changed. In each capacitor, side "A" has the copper around its border etched away to give clearance from side "B". Side "B" forms the "earthy" plate of each capacitor, and is soldered to the tin-plate box. Capacitors C2–C5 are each drilled through their centre and a 10mm diameter clearance area etched on side "B" around the hole.

Producing the capacitors in this way means that they have a very low inductance, so that problems due to self-resonance are removed.

A piece of tin-plate 255 × 160mm is required to make the filter box, and should be cut and drilled according to the layout given in Fig. 8 before bending up and soldering the butting edges. A further piece of tin-plate 125 × 50mm is required for the base-plate, which is a tight fit inside the bottom of the box. The tin-plate should be about 0·5mm thick.

Assembly

Capacitors C1 and C6 are fitted first. Place them as shown in Fig. 5, with the larger area of copper (side "B") in contact with the box, one capacitor at each end. Hold the capacitors firmly in place with a block of wood or foam, turn the box upside down and secure them by melting solder through the holes. It may help if the board is tinned before fitting. Check the soldered connection by pulling on the board to see if it comes away from the box. This is important, as once the other components are fitted, it will be difficult to resolder. The SO239 sockets can now be fitted.

Next fit C2 and C5 so that their "A" sides are 35mm from the end of the box, then C3 and C4 so that they are 14mm from C2 and C5, with the "B" sides facing as shown in Fig. 5. These four capacitors are soldered to the box by each corner of their "B" sides. An iron with a long bit will be found helpful.

When you are satisfied that the capacitors are all correctly positioned, the coils can be fitted. Unless self-fluxing wire has been used, carefully scrape and tin about 5mm at the end of each lead-out, being careful not to deform the coils in any way. Start with L1 and L7, the longer lead going to the socket centre connection in each case, followed by L3 and L5 which are short straight lengths of 22 s.w.g. tinned copper wire, passed through the centre holes of C2–C5 and soldered to their "A" sides. The remaining coils can then be fitted in any order, again being careful not to change the dimensions of the coils (other than to trim the leads to length).

After assembly, check with an ohmmeter that you have continuity between the centre connections of the two co-axial sockets, and that there is not a short to the box. The filter is then ready for use and should be tested before the base-plate is fitted. Note that the printed circuit capacitors are shorter than the sides of the box, leaving a 5mm gap so that the base-plate can be positioned inside the bottom of the box. The base-plate may rest on the top edges of C2–C5, and once in position is soldered to the box at the four corners and in the centre of each long side.

Braid-breaker

The braid-breaker high-pass filter is shown in Fig. 9. This is intended to be fitted in a u.h.f. TV receiver antenna

Fig.4

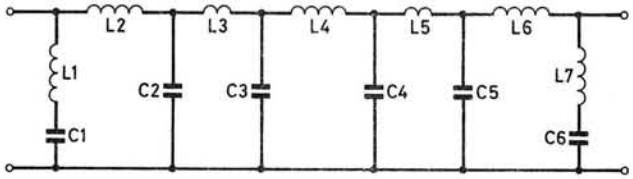


Fig.5

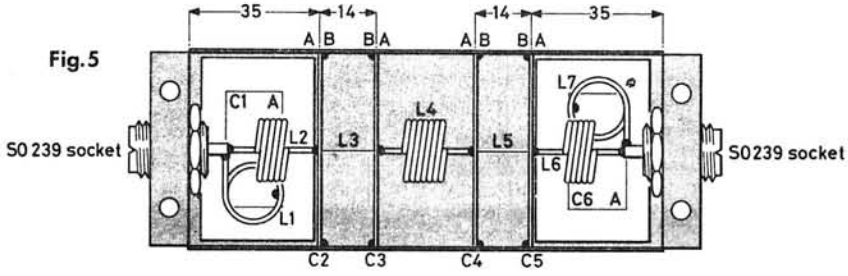


Fig.6

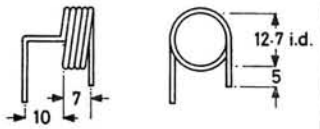
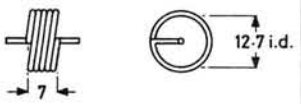
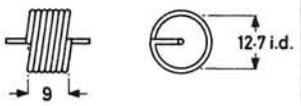
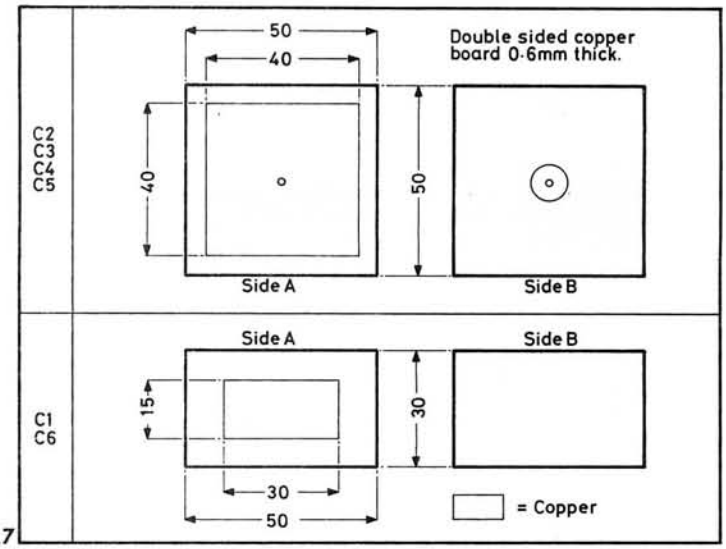
Coil	18s.w.g. enamelled copper wire	Turns
L1 L7		4½
L2 L6		5
L4		7
L3 L5	See text	

Fig.7



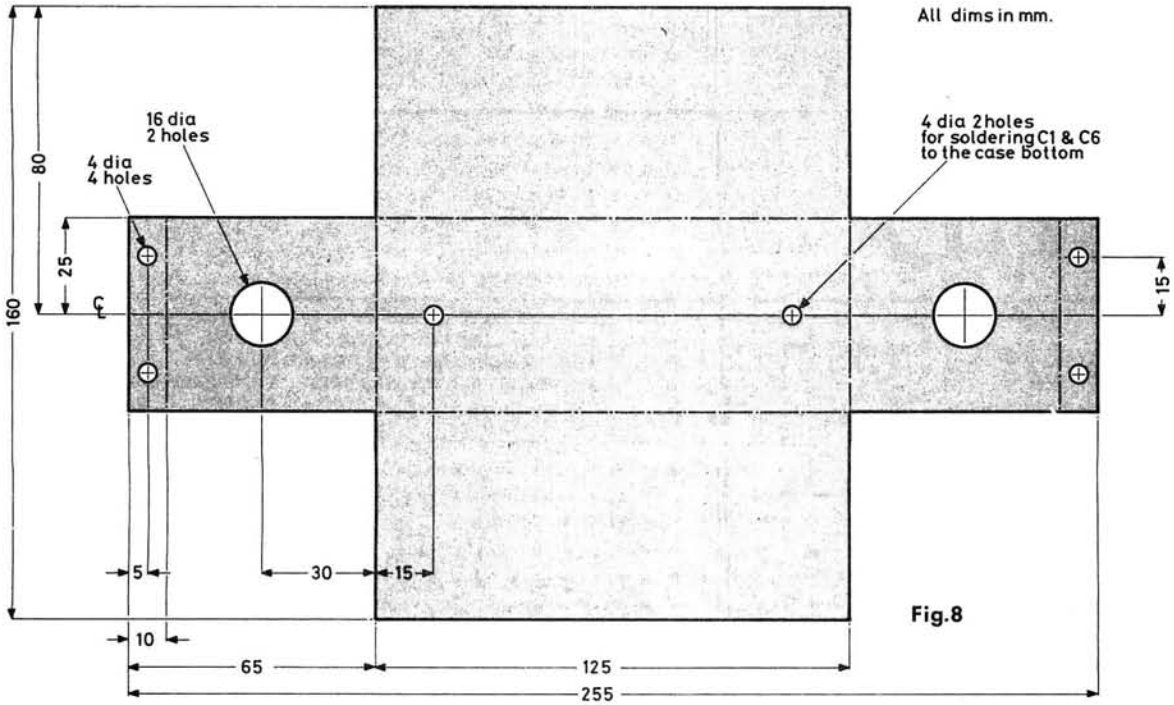


Fig.8

WRM691

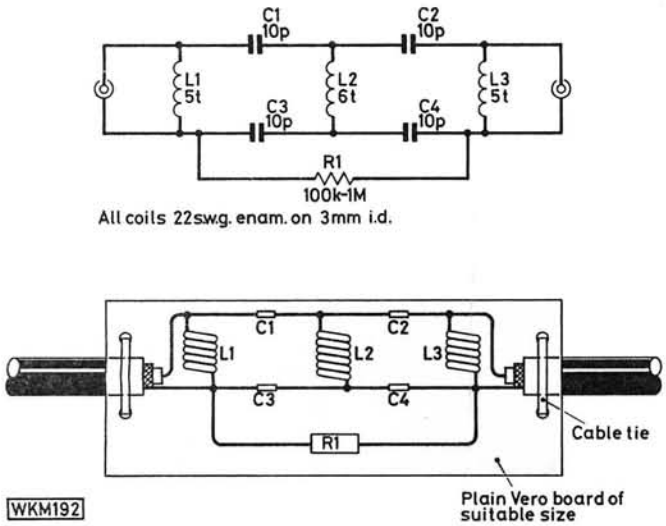


Fig. 9: Braid-breaker high-pass filter. The coils must be mounted not less than 15mm apart

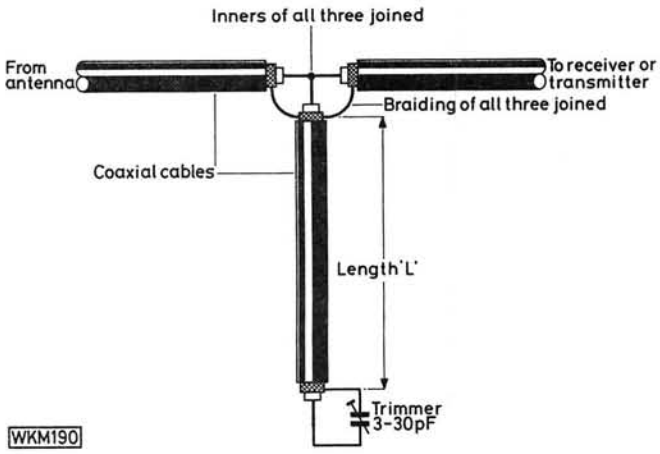


Fig. 10: The quarter-wave stub filter

downlead, allowing the wanted TV signals to pass, but rejecting the interfering signals from a local h.f. transmitter, as described in Part 1. Resistor R1 is a static leak, ensuring that the TV antenna and downlead cannot build up a large static charge when there are electrical storms in the vicinity, but having a high enough value not to "short-circuit" the filter at radio frequencies. The coils are wound from 22 s.w.g. enamelled copper wire on a 3mm mandrel, L1 and L3 having 5 turns and L2 having 6 turns. The capacitors should be miniature or sub-miniature ceramic types.

Plain (unclad) Veroboard makes a simple anchorage for the components, their leads being threaded through the holes and soldered together beneath the board. The coils should be positioned at least 15mm apart. Small plastics cable ties can be used to secure the input and output leads, which are short lengths of 75Ω coaxial cable terminated in TV-type free plugs and sockets.

Stub Filter

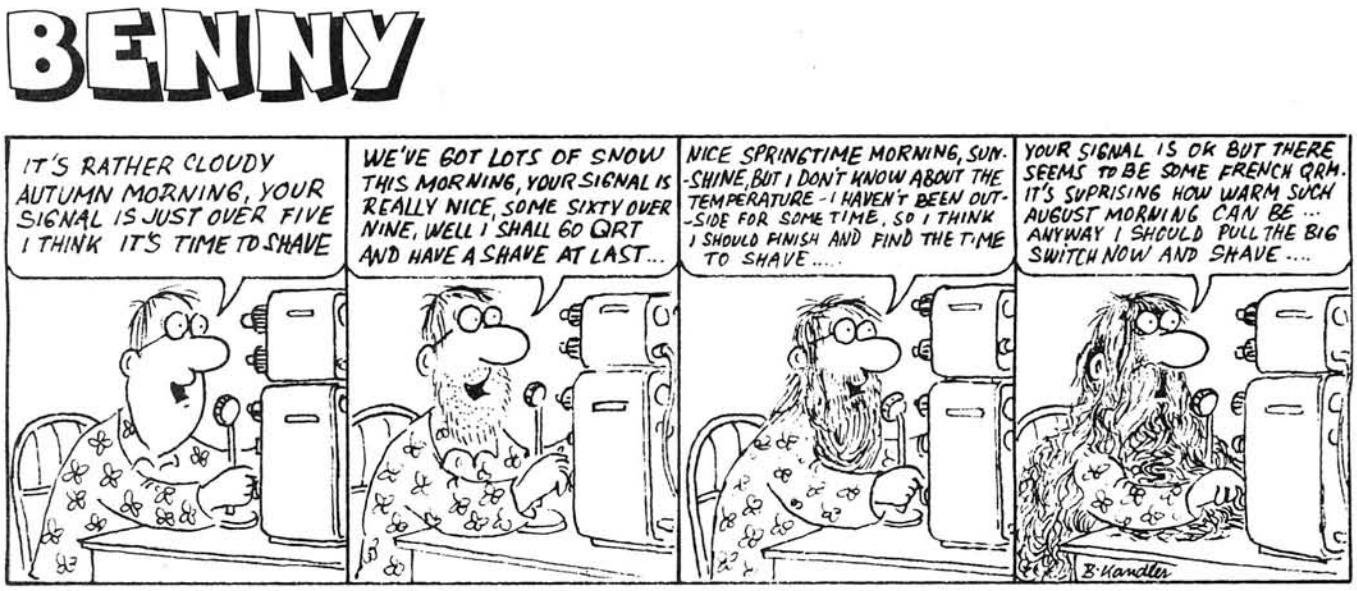
The quarter-wave stub filter shown in Fig. 10 can be used at the transmitter or receiver to provide a sharp rejection notch at the design frequency. The length of the coaxial cable forming the stub is given approximately by the formula:

$$L = \frac{74{\cdot}98 \times 0{\cdot}65}{f} \text{ metres}$$

where f is the design frequency in megahertz, and the 0·65 is an average constant for the velocity factor of the coaxial cable. This factor will vary somewhat between different types of cable, but as an example, a stub for 144MHz would be approximately 0·338m (338mm) long.

The trimmer allows the stub to be tuned to the required frequency and also prevents operation on harmonics. Without this trimmer, the stub could be adjusted to frequency by trimming its length, but it would also act as a stub at frequencies where its length was a multiple of a quarter wavelength. This may prove a problem in some instances, but both methods are worth trying.

In the concluding part of this series, we shall look at the problems of r.f.i. in hi-fi and other electronic equipment.


BENNY
IT'S RATHER CLOUDY AUTUMN MORNING, YOUR SIGNAL IS JUST OVER FIVE I THINK IT'S TIME TO SHAVE
WE'VE GOT LOTS OF SNOW THIS MORNING, YOUR SIGNAL IS REALLY NICE, SOME SIXTY OVER NINE, WELL I SHALL GO QRT AND HAVE A SHAVE AT LAST...
NICE SPRINGTIME MORNING, SUN-SHINE, BUT I DON'T KNOW ABOUT THE TEMPERATURE - I HAVEN'T BEEN OUT-SIDE FOR SOME TIME, SO I THINK I SHOULD FINISH AND FIND THE TIME TO SHAVE.....
YOUR SIGNAL IS OK BUT THERE SEEMS TO BE SOME FRENCH QRM. IT'S SUPRISING HOW WARM SUCH AUGUST MORNING CAN BE ... ANYWAY I SHOULD PULL THE BIG SWITCH NOW AND SHAVE....
B. Kandler

RADIO INTERFERENCE SUPPRESSION

PART 3

E.A.RULE G3FEW

In this, the final part of this short series on r.f.i., we shall be dealing with the problem as it relates to hi-fi equipment, although of course the same remedies can be applied to many other types of electronic equipment. Let it be said right now that there is almost nothing you can do at the transmitting end to cure r.f.i. on hi-fi equipment. Even f.m. still causes problems and in practice actually makes the solution more difficult because you often can't hear anything to identify the cause, unlike s.s.b. or a.m. when the cause is only too obvious! Unless you have heard 50 plus 50 watts of hi-fi stereo s.s.b. in your living room you haven't lived!

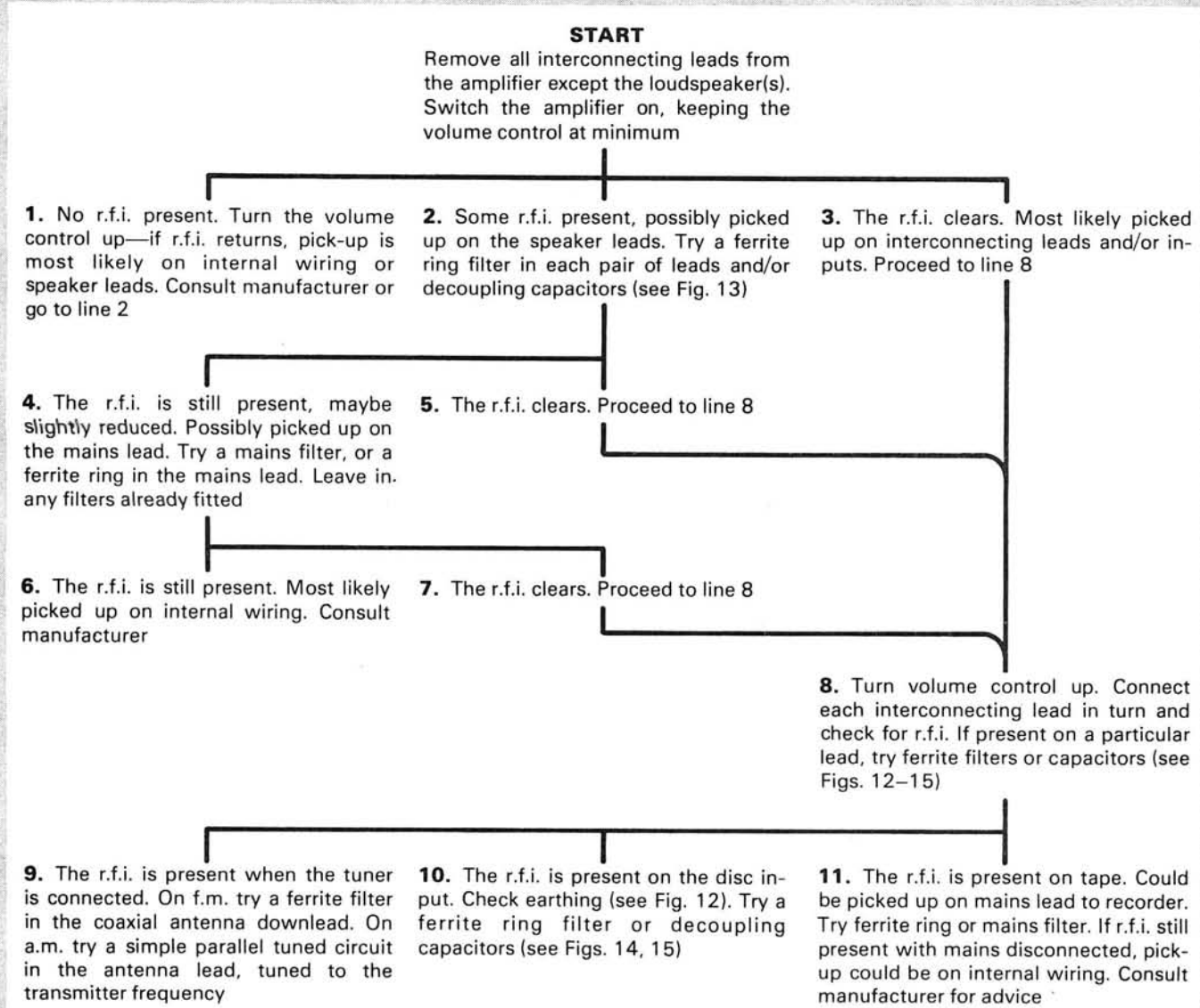

START
Remove all interconnecting leads from the amplifier except the loudspeaker(s). Switch the amplifier on, keeping the volume control at minimum
1. No r.f.i. present. Turn the volume control up—if r.f.i. returns, pick-up is most likely on internal wiring or speaker leads. Consult manufacturer or go to line 2
2. Some r.f.i. present, possibly picked up on the speaker leads. Try a ferrite ring filter in each pair of leads and/or decoupling capacitors (see Fig. 13)
3. The r.f.i. clears. Most likely picked up on interconnecting leads and/or inputs. Proceed to line 8
4. The r.f.i. is still present, maybe slightly reduced. Possibly picked up on the mains lead. Try a mains filter, or a ferrite ring in the mains lead. Leave in any filters already fitted
5. The r.f.i. clears. Proceed to line 8
6. The r.f.i. is still present. Most likely picked up on internal wiring. Consult manufacturer
7. The r.f.i. clears. Proceed to line 8
8. Turn volume control up. Connect each interconnecting lead in turn and check for r.f.i. If present on a particular lead, try ferrite filters or capacitors (see Figs. 12–15)
9. The r.f.i. is present when the tuner is connected. On f.m. try a ferrite filter in the coaxial antenna downlead. On a.m. try a simple parallel tuned circuit in the antenna lead, tuned to the transmitter frequency
10. The r.f.i. is present on the disc input. Check earthing (see Fig. 12). Try a ferrite ring filter or decoupling capacitors (see Figs. 14, 15)
11. The r.f.i. is present on tape. Could be picked up on mains lead to recorder. Try ferrite ring or mains filter. If r.f.i. still present with mains disconnected, pick-up could be on internal wiring. Consult manufacturer for advice

Fig. 11: Hi-fi interference tracing chart. This chart is intended as a general guide only, and does not give all the possible combinations that can cause r.f.i. to be present in an audio system. Start with the basic amplifier and add the various other items one by one, checking each in turn. The effect of r.f.i. can range from mild audio distortion to full-power breakthrough of modulation

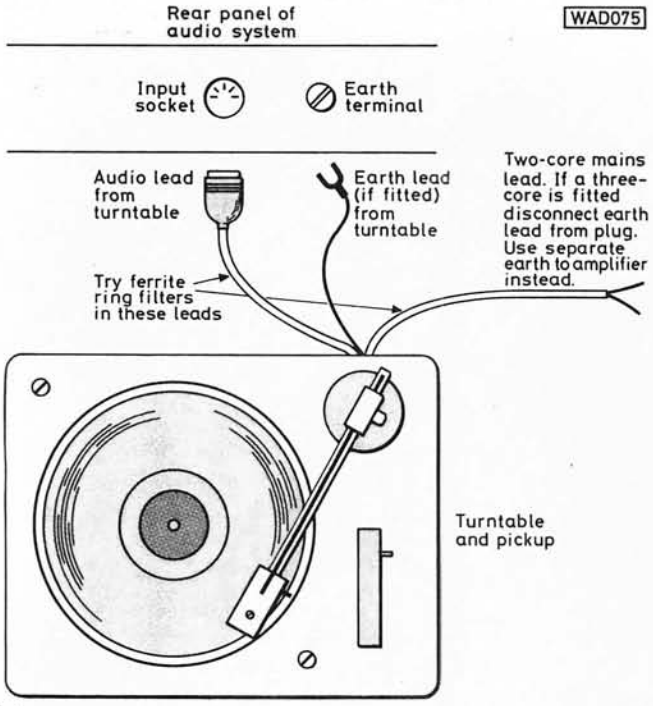

WAD075
Rear panel of audio system
Input socket
Earth terminal
Audio lead from turntable
Earth lead (if fitted) from turntable
Two-core mains lead. If a three-core is fitted disconnect earth lead from plug. Use separate earth to amplifier instead.
Try ferrite ring filters in these leads
Turntable and pickup

Fig. 12: Correct method of wiring a turntable to an amplifier to avoid r.f.i. Tape recorders, tuners, etc., should be wired in a similar way

You can be almost 100 per cent sure that the fault is in the audio equipment suffering from the r.f.i., but this does not mean you don't have to do anything about it. You have a moral responsibility to effect a cure providing the person suffering is willing to co-operate. Unless they are willing to co-operate you stand no chance of effecting a cure other than to stop transmitting, so it's worth repeating: "Do nothing that is likely to sour relationships with your neighbours". Most remedies can be applied externally to the hi-fi equipment and these should always be tried first. If you do find that internal modifications are required, let your neighbour choose a qualified engineer to do the work under your supervision, otherwise you may find that if you touch the internals of their pride and joy, you will be held responsible for every defect from then on. Much depends on your relationship with the neighbour but tread carefully. It is suggested that you pay for any external work and the owner of the audio equipment pays for any internal work, but again this will depend on the local situation.

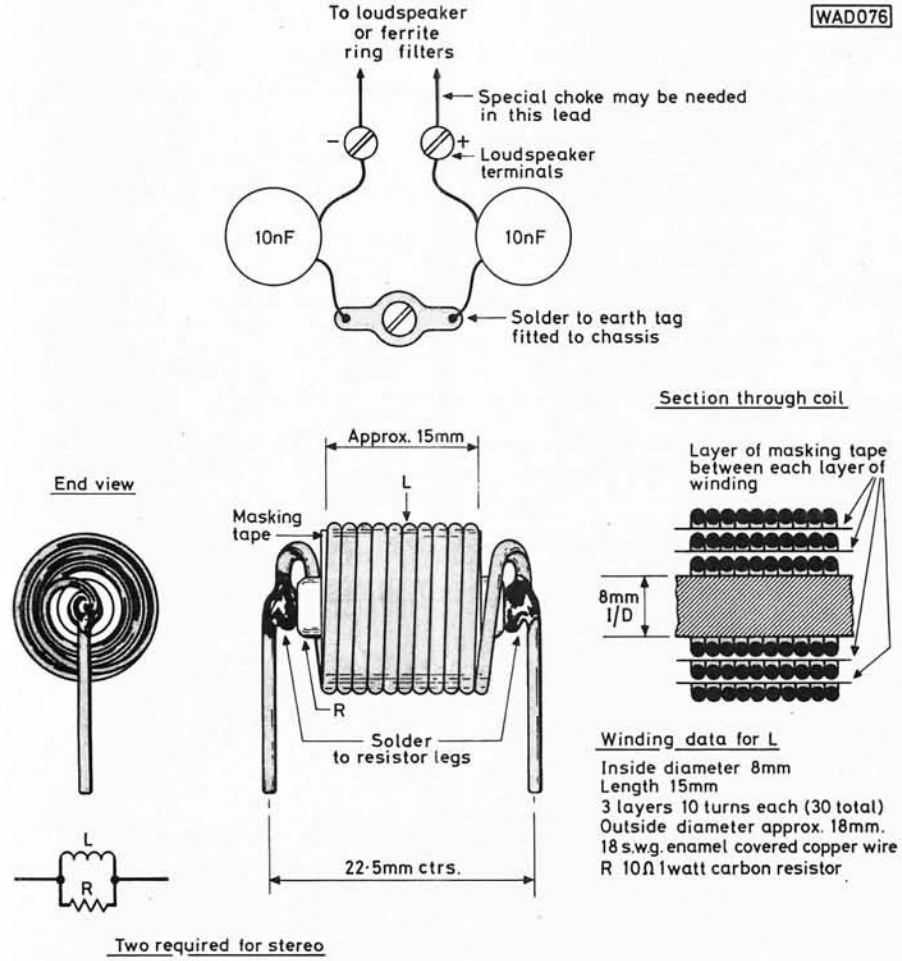


Fig. 13: Correct methods of filtering loudspeaker leads ▲

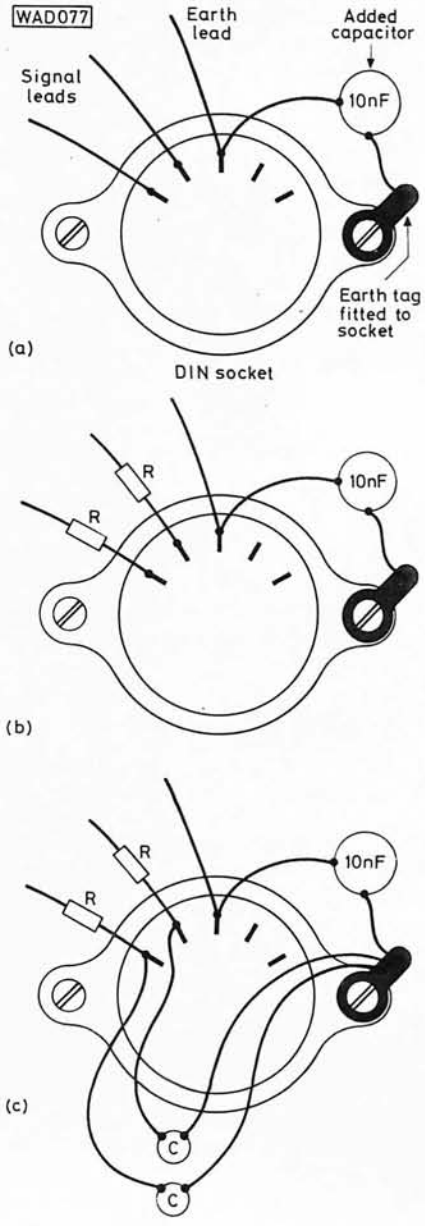


Fig. 14: (a) Adding a decoupling capacitor to bypass r.f.i. picked up on input lead screen. (b) and (c) Adding "stopper" resistors and capacitors to decouple r.f.i. on input signal leads ▶

The chart shown in Fig. 11 is similar to the one given for receivers, but relates to the situation regarding r.f. getting into sensitive audio circuits.

One of the most common ways in which r.f.i. enters an audio system is via the disc (record deck) input. A turntable and pick-up with their wiring are shown in Fig. 12. Some manufacturers fit a wire link underneath the turntable, bonding the metal chassis to the audio earth return. This link should be removed and a separate earth connection run from the turntable chassis to the amplifier earth terminal, not the audio input earth.

It is important that there is only one actual earth connection between the various items making up the system. In general this will be via the audio leads, in which case any other additional earths can be removed if causing r.f.i. Each item (recorder, turntable, tuner, etc.) should be earthed to the main amplifier and **not** to a mains earth. Only the main amplifier should be connected to the mains earth.

Outputs and Inputs

Two methods of filtering loudspeaker leads are shown in Fig. 13. The capacitors, which should be disc ceramic type, should be fitted with the shortest leads practicable, at the speaker terminals or sockets on the amplifier. Some amplifiers may go unstable when capacitors are connected to the speaker terminals. In this case fit one of the chokes shown into the live (non-earthy) lead to the amplifier speaker connectors.

Filtering of input sockets for tuners and tape or record decks should be tackled as shown in Fig. 14. If the input lead screen (pin 2 on DIN sockets) is not taken direct to chassis at the input connector, but goes instead via internal wiring, a 10nF disc ceramic capacitor should be added, as in Fig. 14(a), to decouple this connection from r.f.i.

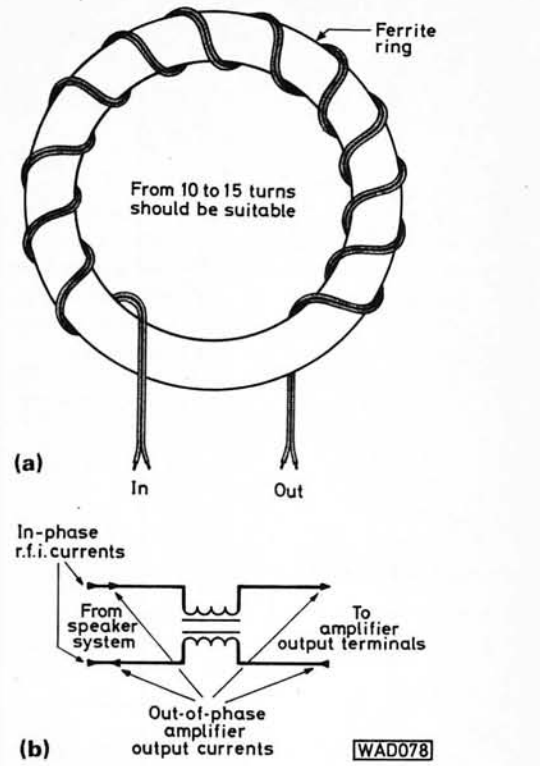
In severe cases, the addition of "stopper" resistors (Fig. 14(b)) and/or capacitors (Fig. 14(c)) may help. For tape and tuner inputs, the resistors "R" may be 10kΩ, but for disc inputs 1kΩ should be suitable. The extra capacitors "C" must be of low value—100pF or less—otherwise the treble response of the amplifier will suffer.

The use of ferrite ring filters is mentioned for mains, loudspeaker, and f.m. antenna leads in Fig. 11. The method of winding the lead onto the ring is shown in Fig. 15(a). The filter should be fitted as close to the amplifier (or the tuner in the case of the f.m. antenna lead) as possible. The principle of operation of the ferrite ring filter for twin leads is shown in Fig. 15(b).

Stopping Detection

All the methods described are intended to stop the interfering radio frequency signal from getting into the amplifier. It will otherwise be "detected" by one of the stages (Fig. 16(a)), after which there is nothing you can do about it, as it will then be treated as a normal audio signal. You MUST prevent the r.f. getting into the amplifier in the first place. However, it is possible to prevent the "detection" process by making certain amplifier stages unsuitable for r.f. operation. Fitting a bypass capacitor (C) of 1nF to 4·7nF across the base/emitter junction of an audio amplifying stage transistor (Fig. 16(b)), will prevent it operating as a detector. In severe cases, a "stopper" resistor (R) of 100Ω to 1kΩ may be added (Fig. 16(c)), but check for any effect this may have on audio reproduction. Normally, only the first stage in the main power amplifier section will need this treatment. Wire the extra components as close to the base/emitter leads as possible.

Fig. 15: (a) Winding a lead onto a ferrite ring to obtain r.f.i. filtering. (b) Principle of a twin-lead ferrite ring filter



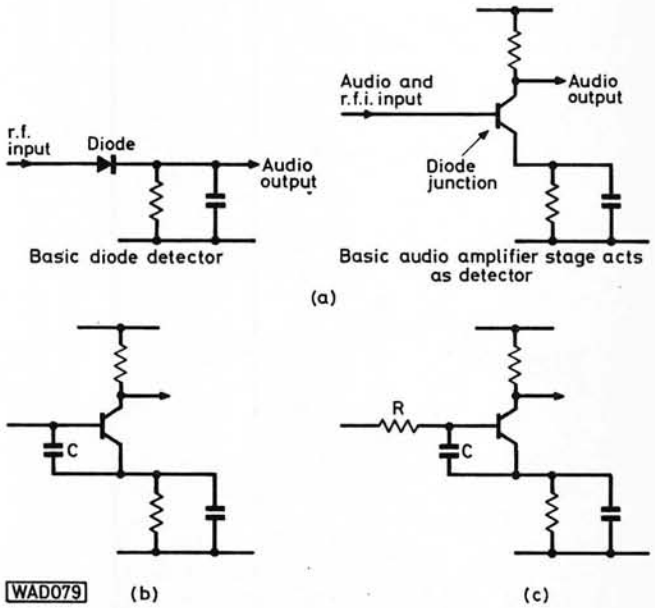


Fig. 16: (a) Similarity between a diode detector circuit and an audio amplifier stage. (b) and (c) Adding suppression components to prevent "detection" taking place

It has not been possible to cover all the aspects of r.f.i. in this short series but it is hoped that the basic ideas given will enable you to work out a solution. Remember that quite often more than one source may be causing the r.f.i. and several filters may be needed before a complete cure is achieved. ●

MODS

IMPORTANT—The ideas presented here are suggestions only, and as they are untried by this magazine, we cannot accept responsibility for any resultant damage, however caused. Before alterations are attempted, care should be taken to ensure that any guarantee is not invalidated, and it should also be borne in mind that modifications usually have an adverse effect on resale prices. In cases where specialist skills or equipment are needed, most dealers will undertake the work for a reasonable fee.

Roger Hall G8TNT(Sam)

No. 19

More mods for the FT-290R this month

Reset to 145MHz

This mod, by Dave Joyce G8MFE, was kindly supplied by SMC Ltd. It should prove very useful to blind operators as it resets the dial to 145MHz (UK versions; 147MHz USA) at the touch of a button and sounds a bleep to signal that it has reset. The first step is to remove the top and bottom covers. Then locate the hole in the case that is very near to the SO239 socket. It is covered on the outside by a stick-on aluminium label. Make a hole in this label and install a push-to-make, non-latching switch. Connect one side of this switch to ground and the other side to Pin 4 of J5003 which connects the keyboard unit to the control unit. A 1nF capacitor should also be connected from Pin 4 to ground for decoupling. Now replace the covers and dial up any frequency. Press the new button and the set should bleep and display 145·00 (147·00 USA).

Mic Gain

Tom G8HUH has sent in two very nice mods. The first allows the user to adjust the gain of the microphone amplifier which, in the FT-290, is normally running at full gain. Tom believes this to be the reason why so much extraneous noise is evident on f.m. transmissions when operating mobile on motorways or in noisy vehicles with this rig. Tom says that to overcome this problem it is essential to be able to reduce the microphone gain and not to be tempted to twiddle with the f.m. deviation control as this is best left alone, especially as it will not make any difference to the background noise. This is another relatively easy mod and the first step is to find chip Q2004. Then lift the earthy end of the 10µF Tantalum capacitor, C20, and re-connect it to earth via a 1kΩ preset pot. Putting this resistance in series reduces the decoupling effect of C20, increasing the amount of negative feedback to the input which in turn reduces the gain of the stage. For ease of adjustment, the pot is best fitted to the component side of the main board. There is a convenient earth pillar nearby. Adjustment should be carried out with a noise source in the background, Tom suggests a vacuum cleaner. Ask several people for their opinion but beware of becoming involved with those strange amateurs who delight in giving false reports. It is also a good idea not to try to carry out these adjustments while mobile on a motorway, even though it might be a test of real life conditions!

Meter Mod

This mod was also supplied by Amateur Electronics UK Ltd., and it is for improving the performance of the output power meter. It should be noted that this meter cannot be used to tune the telescopic whip antenna, even though the meter deflection does vary with changes in the length of the whip. The radiation from this antenna is not necessarily at maximum when the meter is peaked. This mod ensures that the meter indications are relatively independent of the length of the antenna.

This mod is extremely easy to carry out as all that is involved is unsoldering one end of a capacitor (C2038 on the main unit) and re-soldering it in a slightly different position. Fig. 3 shows the original configuration of the circuit and Fig. 4 shows how the top end of C2038 has been moved from the end of L2010 and soldered to the track connecting L2009 to C2098. The readings on the meter should now be much more reliable.

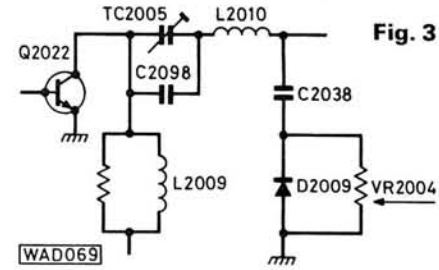


Fig. 3

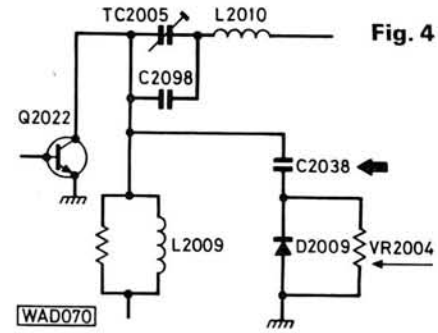


Fig. 4

Squelch Mod

The effects of this mod are threefold:

1. A reduction in squelch hysteresis (the difference in level between the opening and closing points).
2. A speeding up of squelch operation which enables the scanner to work better, also reducing the *squelch tail.*
3. A reduction of hiss level when the squelch is closed. To carry out this mod, reduce C94 from 4·7µF to 1µF, increase R79 from 270kΩ to 330kΩ and then add Cx. This is a 10µF tantalum or sub-miniature electrolytic capacitor and it should be fitted from the leg of R78 (4·7kΩ) to the body of transistor T1007. This useful mod was again supplied by Nick G8MCQ.

The final set of mods for the FT-290R will appear next month